California Environmental Protection Agency

AIR RESOURCES BOARD

AIR QUALITY SURVEILLANCE BRANCH

STANDARD OPERATING PROCEDURE

FOR

BGI PQ-100 AIR SAMPLER FOR SPECIAL PURPOSE MONITORING

AQSB SOP 406

First Edition

MONITORING AND LABORATORY DIVISION

SEPTEMBER 2003

California Environmental Protection Agency
AIR RESOURCES BOARD

Approval of Standard Operating Procedure (SOP)

Title:	BGI PQ-100 Air Sampler for Special Purpose Monitoring
SOP:	AQSB SOP 406, First Edition
Section:	Special Purpose Monitoring
Branch:	Air Quality Surveillance Branch (AQSB)
Division:	Monitoring and Laboratory Division
Prepared by:	Steve Aston, Air Resources Engineer
Approval:	This SOP has been reviewed and approved by:

//s//

Reginald L. Smith, Manager
Operations Support Section
Air Quality Surveillance Branch

9/23/03

Date

//s//

Kenneth R. Stroud, Chief
Air Quality Surveillance Branch

10/7/03

Date

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1.0 GENERAL INFORMATION

1.1 Purpose:

The purpose this document is to provide operational, calibration and maintenance details for the ARB's Air Quality Surveillance Branch's (AQSB) use of the BGI PQ100 air sampler for special purpose monitoring applications. These procedures are intended to supplement the BGI PQ100 Air Sampler Instruction Manual. They will direct the user to appropriate sections of the PQ100 manual. The PQ100 manual should be utilized in conjunction with these written procedures.

1.2 General Description and Principle of Operation:

The PQ100 is a portable programmable mass flow controlled PM10 reference sampler with a microprocessor. It is relatively small 10" x 6" x 9.7", weighs 19 lbs., and operates on 12 volts or 110 A.C. power supply. Flow rates range from 1 to 25 standard liters per minute (slpm). For typical special purpose monitoring application the PQ-100 is operated at 10 slpm.

The PQ100's built in software is programmable to start on any day and time. The built in software produces a LCD display with information such as date, time, flow rate, total flow volume, elapsed time, and internal or external battery conditions. An RS232 port allows downloading of run parameters, which can be printed out using MS-DOS 2.1 or higher.

The PQ100 air sampler continuously monitors flow levels with a mass flow sensor. A schematic diagram of the PQ100's flow system is shown in Figure-1. A signal generated by the mass flow sensor is sent to the microprocessor, which determines if the flow is at the set value. As changes in the mass flow sensor are detected the pump speed changes to maintain the correct set point flow rate. The microprocessor performs other functions such as turning the instrument on at a pre-selected time, sample duration and storing operational data and parameters that can be downloaded.

When configured in accordance with the United States Environmental Protection Agency's (U.S. EPA) manual reference method: RFPS-1298-124, the PQ100 is designated as a reference method for PM-10 monitoring. However, for typical AQSB special purpose monitoring applications, the PQ-100 air sampler is not configured as a PM-10 reference monitor.

The PQ100 air sampler can be configured with different inlets to accommodate PM-2.5, PM-10 or TSP sampling. A variety of filter media can be used with the PQ-100 for special purpose monitoring activities. It is highly recommended to conduct a performance test using the filter media. This is done to determine the effects of the filter media on flow rate and the pressure restriction and how they may affect sampling.

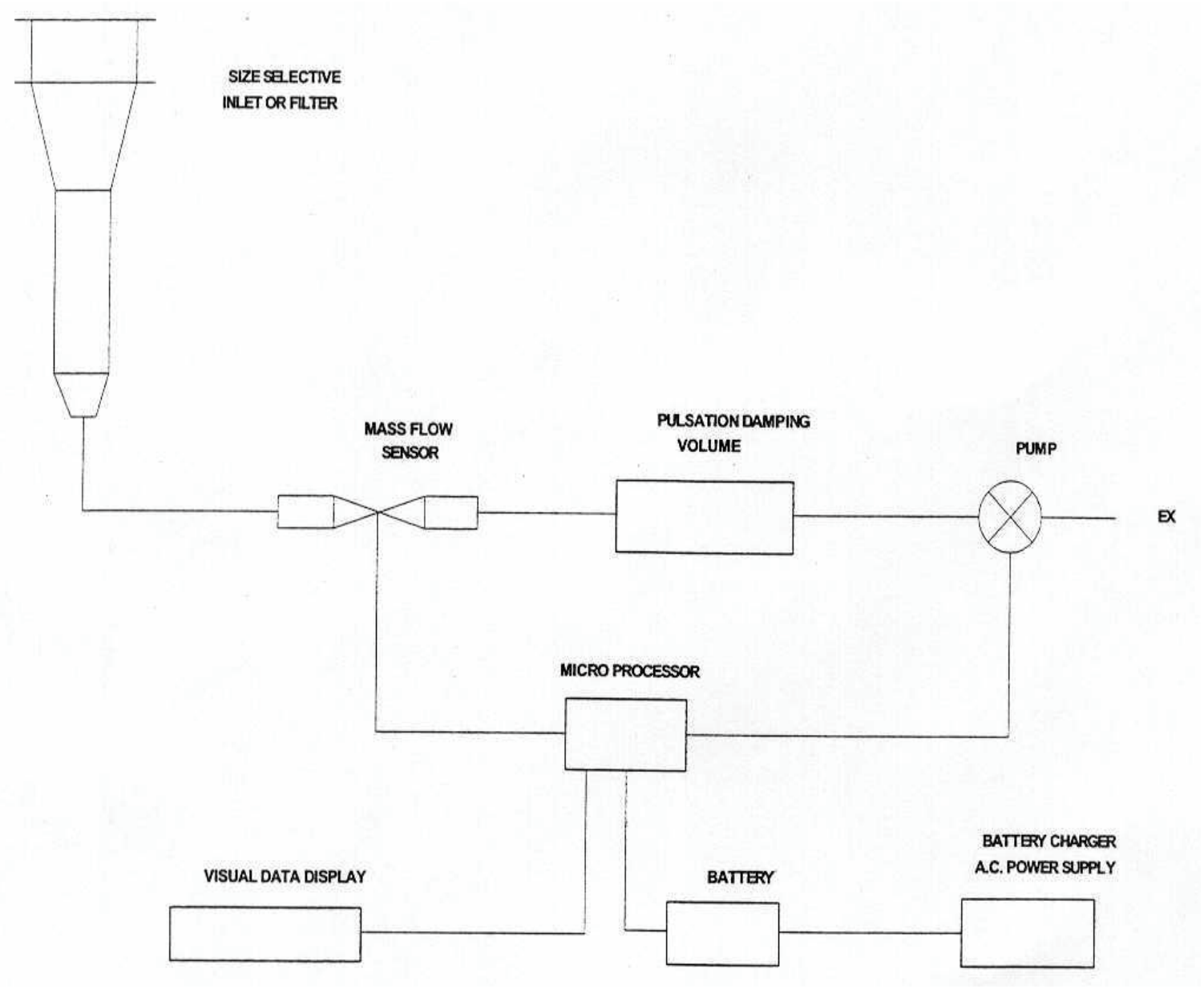

Figure-1
Diagram of Flow System

1.3 Safety Precautions:

Only properly trained personnel should attempt installation, operation, and calibration, of the PQ100s. Additional safety information can be found on page ii in the PQ100 manual.

2.0 INSTALLATION PROCEDURE

2.1 Components:

The PQ100 is a self-contained unit with a mass flow sensor, pulsating dampener, pump, microprocessor, battery and a visual display. Additional components supplied by BGI are listed in sections 2.0 "Getting Started" and 5.0 "Accessories" in the PQ100 Manual. Typical AQSB Special Purpose Monitoring installations should include the following items in addition to the PQ100 main unit.

1. PQ101 battery charger
2. CQ1 charger/battery cable
3. CQ2 PC communication adapter cable
4. CQ3 external battery adapter cable
5. 12 volt external battery
6. PQ100 PC software diskette – 3 ½", 702K
7. 47 mm sampling head/filter holder
8. 47 mm filter with cassette ring
9. Metal tripod which holds 1 ¼" PVC tubing
10. 5 FT 1 ¼" PVC tubing
11. 7 ft of ¼" Teflon tubing
12. Tylan 4 in 1 Mass Flow Meter or BGI Tri-Cal with certification sheet
13. Laptop or PC running MS-DOS 2.1 or higher with 3 ½" floppy drive

2.2 Installation and Siting:

The PQ100 air sampler installation for special purpose monitoring applications is relatively easy. Typical AQSB special purpose monitoring installations include first, setup of the tripod assembly with PVC pipe and then installing Teflon tubing through the PVC to the filter holder and back down to the PQ100 sampling inlet (see Figure-2). For siting and operation requirements refer to 40 CFR Part 58, Appendix E, and ARB Quality Assurance Manual, Vol. II, section 2.0.4.

2.3 Operating Procedure:

To operate the PQ100, press the power ON/OFF button, which will energize the visual display only. Once this is done check the display readouts, elapsed time, total sample volume, date, flow, time, and battery capacity. To change the date, flow rate, time, start time and stop time, and duration you must press the setup button. This will allow you to adjust these parameters by pressing enter to toggle through each display parameter and to make changes by pressing +/- keys. Keep in mind you need to press the setup button to toggle from screen to screen and enter or change settings on a particular screen. Refer to section 6.0 in the PQ100 manual for more detailed instructions.

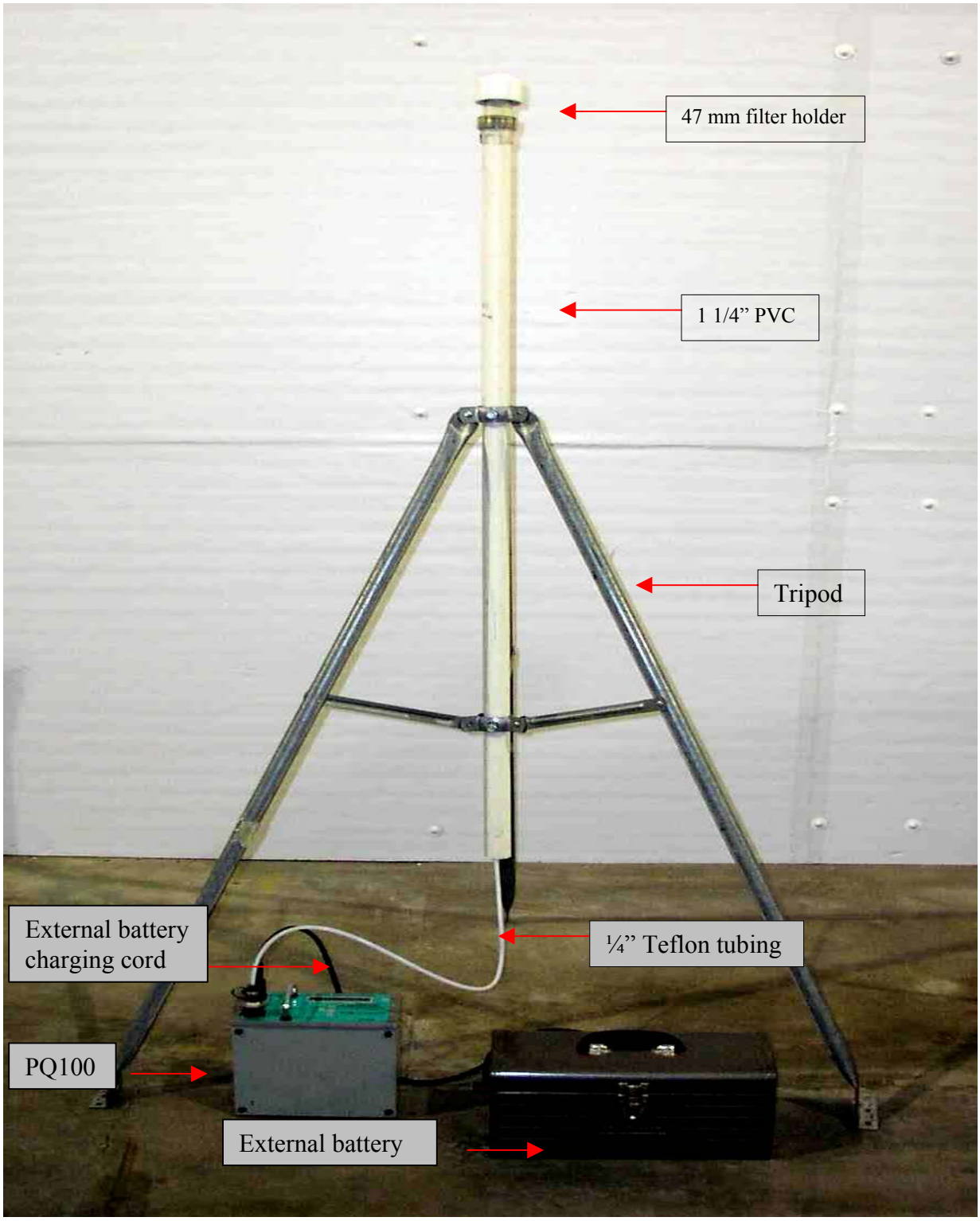

Figure-2
Diagram of Typical Installation

3.0 Configuration

3.1 Software Configurations:

Communication with the PQ100 is conducted via a PC or laptop using the PQ100 software package. To install the software onto your PC or laptop, insert the PQ100 3 ½" floppy disk into the A drive of your PC or laptop, select drive A and run the "INSTALLC.bat" batch program. The installation utility will then create a subdirectory called "PQ" on the C drive and copies all files to it.

The PQ.exe is a menu driven program that utilizes the serial communication port of the PC or laptop to download sample data from the PQ Series Air Sampling Systems. The PQ.exe allows the user to communicate with the PQ100 and downloads run data from the PQ100 to your PC or laptop.

Using the PQ100 software is made easy by creating an MS-DOS shortcut icon on your desktop. This can be done by going into programs, going to the MS-DOS program and right clicking and selecting "create shortcut". Once this is done you can drag the shortcut key to the desktop and every time you want to access the PQ100 software just double click on the shortcut key. From the MS-DOS prompt, type in "PQ" then enter. This will bring to the PQ100 Main Menu Figure-3.

PQ100 SOFTWARE MAIN MENU

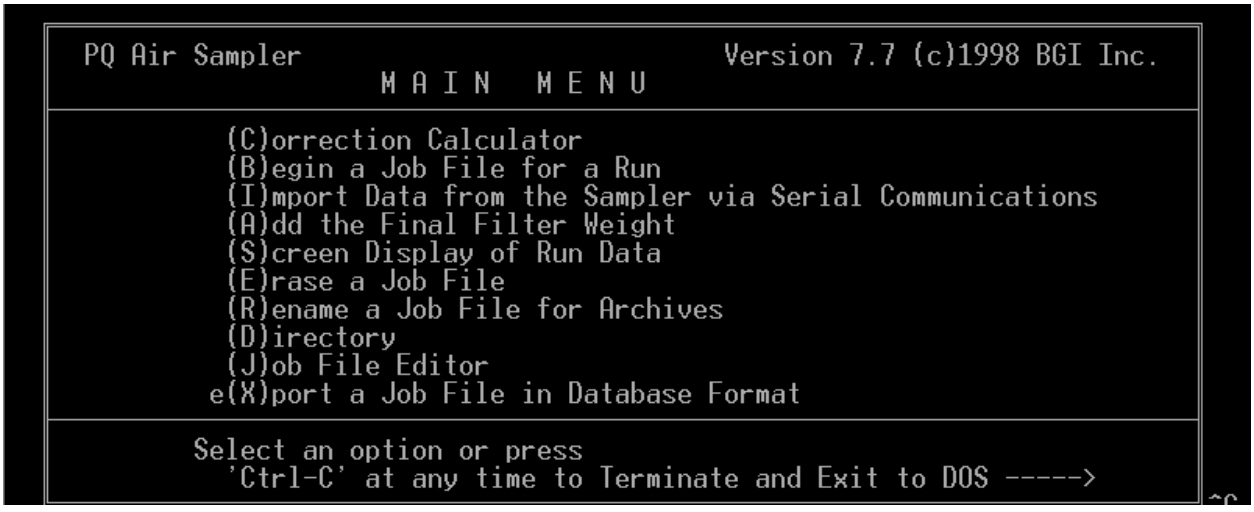

Figure-3
Diagram of PQ-100 Software Main Menu

Before you can download data from the PQ100 you must (B)egin a Job File for a Run. You will be prompted to enter a filename or a job name, e.g. location and date, maximum 8 characters, sample site, station code, job code, operator, filter number, and if needed the initial filter weight Figure-4.

After the file has been created you can download data from the PQ100 by connecting the RS-232 interface cable (CQ2) to the PC then to the PQ100. Now just type (I)mport data from the sampler via the serial port. The program will then ask you for the job file, which you have just created prior to download. Type it in and press-enter and the following screen will appear with the run data.

PQ100 RUN DATA

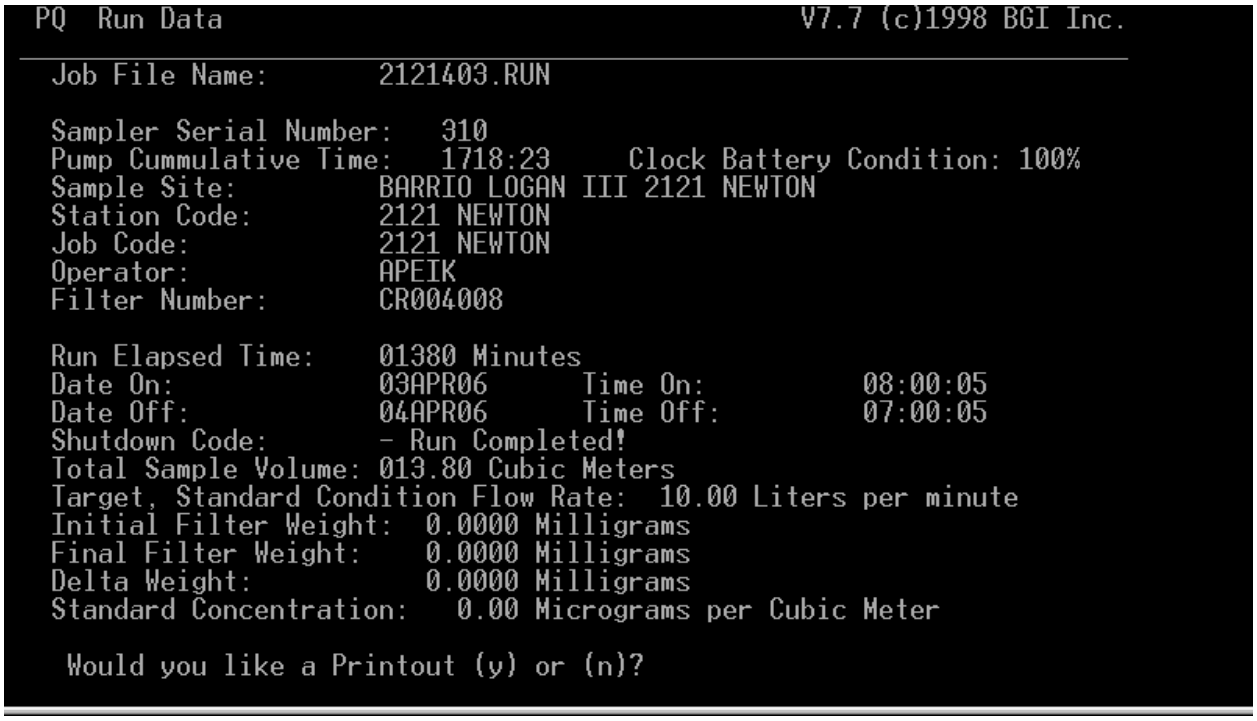

Figure-4
Diagram of PQ100 Run Data

The PQ Run Data will automatically display the sampler serial number, pump cumulative time, clock battery condition, run elapsed time, dates on and off, shutdown code, sample volume, flow rate along with a hourly average flow rates for the duration of the run time Figures-4 and 5.

PQ100 HOURLY AVERAGES

```
 PQ  Run Data                                        2121403.RUN

The Flow Rate of the PQ100 is monitored and sampled during each run to indicate
Flow Rate stability per OLD EPA 40 CFR part 53.43.
The Initial reading is stored 2 minutes after the Flow Rate has stabilized.
Readings are then accumulated on an hourly basis.  The table below shows
the flow rate at each hourly interval followed by the percent difference
between it and the initial reading.

 Target (Initial) Flow Rate:  10.00 Lpm
 Average Flow Rate:  10.00Lpm  Percent difference from Initial: 0.00
 Hour01) 10.00Lpm 0.00    Hour11) 10.02Lpm 0.20    Hour21) 10.00Lpm 0.00
 Hour02) 9.95Lpm -0.50    Hour12) 9.97Lpm -0.30    Hour22) 10.07Lpm 0.70
 Hour03) 10.02Lpm 0.20    Hour13) 9.97Lpm -0.30    Hour23) 0.00Lpm 0.00
 Hour04) 10.02Lpm 0.20    Hour14) 10.02Lpm 0.20    Hour24) 0.00Lpm 0.00
 Hour05) 9.90Lpm -1.00    Hour15) 9.97Lpm -0.30    Hour25) 0.00Lpm 0.00
 Hour06) 10.02Lpm 0.20    Hour16) 9.97Lpm -0.30    Hour26) 0.00Lpm 0.00
 Hour07) 10.02Lpm 0.20    Hour17) 10.02Lpm 0.20    Hour27) 0.00Lpm 0.00
 Hour08) 10.00Lpm 0.00    Hour18) 10.05Lpm 0.50    Hour28) 0.00Lpm 0.00
 Hour09) 10.02Lpm 0.20    Hour19) 9.97Lpm -0.30    Hour29) 0.00Lpm 0.00
 Hour10) 10.00Lpm 0.00    Hour20) 10.02Lpm 0.20    Hour30) 0.00Lpm 0.00

  Would you like a Printout (y) or (n)?
```

Figure-5
Diagram of PQ-100 Flow Rate Hourly Averages

At the end of each screen you have the option to print out the PQ Run Data. This is an excellent way of keeping track of run data and parameters, as well as a tool for maintaining the PQ100's components.

4.0 CALIBRATION PROCEDURES

4.1 General Information:

Calibration of the PQ100 consists of several procedures, which are described step by step in Section 7 “Calibration” of the PQ100 manual. The manufacturer's procedures should be followed. The frequency of calibrations and the required apparatus are summarized as follows:

FREQUENCY	APPARATUS
1. Every Deployment	a. Certified flow rate transfer standard
	b. Certified thermometer and barometer transfer standard
	c. Filter holder adapter
	d. 5 feet of 1/4" I.D. Teflon tubing
	e. Filter media to be used

4.2 Calibration Procedure:

Prior to calibration of the PQ-100 air sampler, a leak test should be performed. Obstructing the air flow by placing your hand over the air inlet at the filter can accomplish the leak check. Within a few seconds the PQ100 will power-down and shut off if there are no leaks in the system. If a leak is discovered, start by checking all connections from the filter back to the pump inlet of the PQ-100. Thus, isolating the air leak and performing necessary repairs. If the leak is downstream from the PQ-100 pump inlet notify BGI for consultation.

To enter the calibration mode turn the PQ100 on and the main idle display screen will come up. Press the setup key once and the flow rate screen will appear. Make sure the start date enable is set to off, so the pump will run in manual. Press the Reset key and the Run/Stop key simultaneously to enter the calibration mode. The screen will show the calibration target flow rate. Then press the Run/Stop key to start the pump. The flow rate can be adjusted by using the +/- keys. The flow rate will change by tenths, which allows you to reach the proper flow rate for the current ambient conditions designated by the certified transfer standards. Once you have obtained the proper flow rate press the enter key which will store the new flow values in PQ100’s memory. This will stop the PQ100’s pump. Press the Run/Stop key and check to see if in fact the proper flow rate has been stored in the PQ100’s memory.

Note: Pre and Post Calibrations should be performed in the field at actual conditions.

This procedure consists of measuring flow rates with a certified transfer standard with the filter media in place and for the ambient conditions.

CAUTION: CARE SHOULD BE TAKEN WHEN USING CALIBRATION MODE. IT IS NOT USED TO CHECK CALIBRATION FLOW RATE. INCORRECT USE CAN ERASE A PREVIOUSLY STORED CALIBRATION. IF YOU SIMPLY WISH TO CHECK THE FLOW RATE ACCURACY FOR THE SELECTED TARGET, GO TO THE MAIN IDLE DISPLAY AND PRESS "RUN/STOP". ENSURE THE START DATE ENABLE IS SET TO "OFF" (SECTION 6.9 IN THE PQ MANUAL).

5.0 ROUTINE SERVICE CHECKS

5.1 General Information:

Detailed directions of routine service checks are described in Section 10.0 "Maintenance and Service" of the BGI PQ100 Manual. This section has a list of replacement components and directions on rebuilding the pump and replacing the mass flow sensor.

5.2 Daily Check:

On a daily basis, viewing the LCD display screen when you first turn on the sampler. Check the internal battery capacity, date, time, flow rate, elapsed time, and total volume. Reset display as needed. Also check the PQ Run Data Screen to check the internal clock battery capacity and the total cumulative pump hours.

5.3 Weekly Check:

On a weekly basis, record the pump cumulative hours, the internal clock battery capacity, and the main internal battery capacity.

The pumps should be rebuilt after 5000 hours of service and the internal clock battery should be replaced every two years along with mass flow sensor.

5.4 Biweekly Check:

Every two weeks perform and record the results of flow checks for ambient temperature and pressure conditions, see Appendix A.

The AQSB has established a policy that a precision flow check be performed at least every two weeks when using the PQ-100 for special purpose monitoring. This is accomplished by measuring flow rates by attaching an adapter to the top of a 47 mm sampling head and connecting it to the transfer standard with ¼" Teflon tubing. Then compare measurements to the PQ100 indicated flow rates as shown on its LCD display.

Record these readings and measurements on the field check sheet and if they differ by more than 4%, take corrective action, refer to Appendix J in the PQ100 manual, and notify your supervisor. The flows may be measured with a bubble meter or mass flow meter (MFM) which has a flow range from 0 to 25 LPM.

Flow may need to be mathematically converted to volumetric LPM using the slopes and intercepts of the certified transfer standard at ambient pressure and

temperature conditions. The BGI Tri-Cal displays the LPM in actual/ volumetric flow, so no conversion is necessary. The equations for this conversion is as follows (if needed):

$$VLPM = \frac{760 \text{ mm Hg}}{Pa \text{ mm Hg}} \times \frac{Ta + 273\ ^{\circ}K}{298\ ^{\circ}K} \times SLPM$$

Where: Pa = Ambient Pressure in mm Hg
Ta = Ambient Temperature in °C

Note: Pa and Ta are measured from a certified pressure and temperature transfer standard.

The procedures to perform the precision flow check are as follows:

1. Place a clean filter of the type to be used for the sampling in the PQ100.

2. Remove the rain shield cover from the filter holder and place the connecting head on top of the filter holder inlet. Observe the digital display readings on transfer standard.

3. Record the barometric pressure and temperature at the time of calibration.

4. Measure and record the flow rate.

5. Re-install rain shield cover

6. Calculate and record the percent deviation of PQ100 indicated main flow rate from the measured flow rate using the following formula:

$$\% \text{ Deviation} = \frac{(\text{BGI indicated} - \text{Transfer Standard})}{\text{Transfer Standard}} \times 100$$

Where: BGI Indicated = flow rate as indicated on PQ100 display
Transfer Standard = flow rate as measured by transfer standard

6.0 MAINTENANCE AND PROCEDURES

6.1 General Information:

A replacement component list can be found in section 10.0 “Maintenance” of the PQ100 manual. Replacement parts can be ordered directly from BGI, (refer to Appendix K) in the manual to get and assembly view of the PQ100 working parts.

6.2 Instrument/Sampler Maintenance:

The PQ100 pump should be rebuilt after 5000 hours of operation. To determine pump cumulative time you must use the PQ software to obtain a download from the PQ100 (see section 8.9 “Downloading Data” in the PQ100 manual). Pump cumulative time is the number of actual service hours of the dual diaphragm pump and is shown when either printing or screen viewing the download. When this time exceeds 5000 hours the pump should be rebuilt. The rebuild is a relatively easy task and requires the replacement of the diaphragms, valves, and bearing. A kit of parts is available from the factory and includes instructions the factory can also perform (service). See section 10.2 “Rebuilding pump after 5000 hours” and 10.3 “Replacement of the mass flow sensor” in the PQ100 manual for kit numbers descriptions and further maintenance information.

7.0 TROUBLESHOOTING

Refer to Appendix B, C, and E in the PQ100 manual to obtain information regarding troubleshooting, battery conditions, and shutdown messages.

CALIFORNIA AIR RESOURCES BOARD
AQSB MONTHLY QUALITY CONTROL MAINTENANCE CHECKSHEET 406
BGI PQ100

Location: _____ Month/Year: _____
Station Number: _____ Technician: _____
Property Number: _____ Agency: _____

1. Daily Checks: Check LCD internal battery capacity, correct date, time, flow rate, elapsed time, total volume, and total cumulative pump hours.
2. Weekly Checks: Record pumps cumulative hours, the internal clock battery capacity, and the main internal battery capacity.
3. Biweekly Checks: Every two weeks perform and record the results of flow checks on the monthly data sheet (≤ 4%).

Transfer Standard Information:
MFM Make & Model: _____ Flow Range: _____
I.D. (Bar Code): _____ Calibration Date: _____

Date	Sampler I.D.	Transfer Standard Flow Rate (slpm)	Sampler Flow Rate (slpm)	Dev. From True %	Clock Battery %	Internal Battery %	External Battery %	Pump Hours

Operator Comments:

APPENDIX A (9/03)

AQSB Pre-Sampling Calibration Form 406

Transfer Standard information:

Transfer Standard Make & Model: Certification Expiration Date: Slope & Intercept:
I.D. (Bar Code):
Temp (K):
Press (mmHg): Project:

		Pre-Sampling One Point Flow Calibration				
Date	Sampler I.D.	Transfer Standard Display (lpm)	Standard Flow Corrected Qstd (lpm)	Volumetric Flow Calculated Qa (lpm)	Volumetric Flow Display BGI PQ-100 (lpm)	Pre-Sampling % Difference

Qstd = (Slope*Display + Intercept) Performed by: Date:
Qa = Qstd (Pstd/Pa)*(Ta/Tstd)
%Difference = ((Transfer Standard Display - Volumetric Flow Display)/Volumetric Flow Display)* 100

APPENDIX (3/03)

AQSB Post-Sampling Form 406

Transfer Standard information:

Transfer Standard Make & Model: Certification Expiration Date: Slope & Intercept:
I.D. (Bar Code):
Temp (K):
Press (mmHg): Project:

		Post-Sampling Flow Check As Is				
Date	Sampler I.D.	Transfer Standard Display (lpm)	Standard Flow Corrected Qstd (lpm)	Volumetric Flow Calculated Qa (lpm)	Volumetric Flow Display BGI PQ-100 (lpm)	Post-Sampling % Difference

Qstd = (Slope*Display + Intercept) Performed by: Date:
Qa = Qstd (Pstd/Pa)*(Ta/Tstd)
%Difference = ((Transfer Standard Display - Volumetric Flow Display)/Volumetric Flow Display)* 100

APPENDIX C (3/03)

24-Hour Filter Media Log/Transfer Sheets (PQ 100)

*Site Name:*_____ *Filter I.D. or Code:*_____

*Sampler I.D.:*_____ *Start Date / Time:*_____

*Field Operator:*_____ *End Date / Time:* _____

Sample Summary:

Elapsed Time (min)	Target Flow Rate (slpm)	Total Volume Sampled (liters)	Observed Conditions

Observed Conditions
A. No Unusual Conditions
B. Rain / Snow
C. Fog
D. Nearby Smoke / Fire
E. Construction
F. Sampler Malfunction
G. Other (state)

Operator Comments:

_____

_____

_____

Filter / Sample Transfer:

Action	Date	Time	Initials		Comments
			Released	Taken	
Filter transferred from lab to site operator					
(Filter transfer)					
(Filter transfer)					
Filter transferred from site operator to lab					

APPENDIX D (3/03)